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Chapter 3: *Phonology* S.J. Hannahs

Key terms: phonotactics, syllable, obstruent, sonorant, phoneme & allophone, conditioning factors, underlying vs. surface forms, complementary distribution, contrastive distribution, onset, coda, rhyme, stress, minimal pair, neutralization, flapping

Preview: Overview of phonology

The focus of the last chapter was on phonetics, examining the characteristics of speech sounds, how they are produced and their physical properties, along with important related issues such as tone and intonation, and the crucial distinction between (phonetic) transcription and (orthographic) spelling systems like English writing. In this chapter we turn to phonology, which focuses on the systematic organization of speech sounds. As we will see, there are systematic behaviours in the speech sounds of language that cannot be attributed to the phonetics alone. We will also see that some aspects of the sound system of language – for instance, native speakers' intuitions about the relationships among the sounds of their language which may be at odds with phonetic reality – can be best understood at an abstract level of representation.

3.1 Introduction

In the previous chapter it was pointed out that phonetics deals with the characteristics of speech sounds themselves, while phonology deals with the organization of speech sounds into systems. There are aspects of the sound systems of human languages that cannot be explained by phonetics alone. Consider first the Greek word *πτέρυγα* [ˈptɛrɪɣɑ] 'wing', the French word *psychologie* [psikɔlɔʒi] 'psychology', and the German word *Knie* [kniː] 'knee' (and remember that the symbols in square brackets [ ] show how the words are pronounced).

And now consider English: there are no words beginning with the sounds [pt], [ps] or [kn]. Since Greek, French and German are human languages, it cannot be the case that [pt], [ps] and [kn] are impossible (for human beings) to pronounce. Rather, it is a fact about the organization of the sound system of English that initial [pt], [ps] and [kn] are disallowed. Looking more closely, it is not really a fact about words, but a fact about **syllables**: English syllables do not begin with [pt], [ps] or [kn]. Recall from Chapter 2 that English spelling does not accurately represent how words are pronounced. There *are* words of English spelt with <pt>, <ps> and <kn>, as in *pterodactyl*, *psychology* and *knee*, but there are no words of English in which these sequences are routinely pronounced at the beginnings of words or even at the beginnings of syllables. In these cases only one of the initial consonants is pronounced: [tɛɹəˈdæktəɬ], [saɪˈkɔlɔʤiː], [niː].

To return to the point that phonetics alone does not explain all aspects of sound systems of language, what is going on here is that the phonology of English – the system organizing the sound patterns of the language – does not allow these particular combinations in specific positions. Take the sequence [pt] for instance. It is fine at the end of a word, like *kept*, *stepped*, *flipped*, etc. It can also occur in words like *apt* or *captain*, or in phrases like *hop to it!* or *up town*. What is the difference? In the cases where the sequence is allowed, the [p] and the [t] are either at the end of a syllable (where the dot indicates a syllable boundary) – [.kɛpt.], [.æpt.] – or in different syllables – [.ˈkæp.tən.], [.ʌp.ˈtaʊn.]. In none of these cases do the [p] and [t] occur together at the beginning of a syllable.

Interestingly, it is not just specific combinations that are disallowed in specific places,

particular segments may also be disallowed in specific positions within a syllable. Take English again: words may begin with the sound [h] – *hat, head, hot, heavy, heartfelt, happy* – but words do not end with [h] in English. Again, spelling does not count! Words like *verandah* and *savannah* which may be spelt with <h> at the end are not pronounced with a word-final [h]. Note, though, that we can find non-initial [h] pronounced in English, in words like *ahead*, *behind*, *perhaps*. So, it is not the case that [h] in English can occur only at the beginnings of words. In all of these cases, the [h] occurs at the beginning of a syllable: *a.head*, *be.hind*, *per.haps*, *head*, *ha.ppy*.

Looking once again at the beginnings of words, consider the velar nasal, [ŋ], the final sound in *thing* [θɪŋ], *hang* [hæŋ], and so on. English words happily end with [ŋ], but they do not begin with that sound. Again, though, we can find [ŋ] in the middles of words, e.g. *finger, ringtone*, but once more, the syllable is crucial: the [ŋ] appears only at the ends of syllables, i.e. [ˈfɪŋ.gə], [ˈɹɪŋ.toʊn].

The facts about [h] and [ŋ] could, of course, be facts about phonetic possibilities in human language. And if we never found initial [ŋ] or final [h] in any language we would be supported in that conclusion. Unfortunately for that hypothesis, there are languages which routinely pronounce final [h], e.g. Navajo, with words like *gah* [kɑh] 'rabbit' and *tooh* [tʰoːh] 'lake'. Likewise, there are languages which regularly pronounce initial [ŋ], e.g. Samoan, in words like [ŋaŋana] 'language' and [ŋaːlue] 'to work'.

Throughout this chapter we will explore various ways in which speech sounds are organized into systems, and ways in which that organization goes beyond the phonetic facts.

3.2 **Phonotactics and syllables**

The illustrations above are to do with **phonotactics**, in other words, the allowable combinations of speech sounds in a particular language. Again, it is important to recognize that phonotactics are language specific. That means that the allowable combinations of speech sounds can vary from language to language, just as we have seen that Greek, French and German allow syllable-initial [pt], [ps] and [kn], respectively, but English does not.

Consider another illustration of this. In English there are no native words beginning with *[pw], *[bw], *[fw], *[vw], *[mw] (here the asterisk means 'does not occur'). That is, words like *[pwiːm], *[bwaɪf], *[fwɪɬ], *[vwɔt] and *[mwæp] are not possible words of English – despite the fact that English speakers can easily (learn to) pronounce them. How can we tell that this is a fact about English? Because other languages allow words beginning with [pw], [bw], etc. For instance, Spanish is perfectly happy with words like *puedo* [pweðo] 'I can', and *bueno* [bweno] 'good, masc.' Note, too, that forms like *[pwiːm] and so forth are not just non-occurring words of English, they are impossible words of English. Compare, for instance, something like [stɹɪɬp], which is a perfectly acceptable English word but which happens not to exist. So, we can say that [stɹɪɬp] is a possible but non-occurring word of English.

There are at least two questions you can ask about the restriction in English on words like *[pwiːm], *[bwaɪf], *[fwɪɬ], *[vwɔt] and *[mwæp]. Is it a restriction on any sequence of p+w, b+w, f+w, etc.? In other words, is it some general prohibition on [w] following [p], [b], [f], [v] and [m]? Or can the sequence occur in some contexts? The second question is this: can we observe anything about these particular combinations of sounds? That is, is there some generalization we can make about these words, and specifically these combinations of sounds, to help us understand the restriction?

Let us look first at the question of the sequence of p+w, b+w, and the others. In fact, we can find sequences of these sounds in English, both in phrases like *sleep well*, *live with*, *slim wife*, and in words like *leafworm*, *labworker*, *livewire*. What is it that makes these sequences different from those in *[fwɪɬ], *[pwiːm], etc.? The difference is that in *sleep well* and *live with*, and the other occurring sequences, there is a syllable boundary between the [p] and the [w] and between the [v] and the [w], [.sliːp.wɛɬ.], [.lɪv.wɪð.]. The [fw] and [pw] in *[.fwɪɬ.], *[.pwiːm.], on the other hand, are not separated by a syllable boundary. So the generalization seems to be this: the sequences [pw], [bw], [fw], [vw], [mw] can occur in English provided that they are in different syllables.

Can we say anything more about this? Yes. As a logical puzzle, it might be the case that English disallows syllables to begin with a combination of consonant + [w]. But consider this: there are consonants of English that can occur at the beginnings of words, and therefore

syllables, followed by [w], such as *twine* [twaɪn], *dwell* [dwɛɬ], *sweep* [swiːp] *queen* [kwiːn], *Gwen* [gwɛn]. How do these words differ from the impossible words above, *[pwiːm], *[bwaɪf], *[fwɪɬ], *[vwɔt] and *[mwæp]?

Recall in the previous chapter, Section 2.2, different places of articulation were discussed. Now consider the sounds we are interested in here. As we have just seen, the consonants [t], [d], [k], [g] and [s] can all occur before [w] at the beginning of a word. These consonants, [t], [d], [k], [g] and [s], are all '**obstruents**', in other words oral stops or fricatives. Do these consonants have some shared property, apart from simply that of being obstruents? Not really one that would help us here: [t], [k] and [s] are voiceless while [d] and [g] are voiced; [t], [k], [d] and [g] are stops while [s] is a fricative. Place of articulation, is also not shared, as [t], [d] and [s] are alveolars while [k] and [g] are velars.

But now consider the consonants that cannot precede [w]: [p], [b], [f], [v], [m]. They are also a mixture of voiced and voiceless, they also include stops and fricatives – and a **sonorant**. But what about place of articulation? The consonants [p], [b] and [m] are bilabial, while [f] and [v] are labiodental. What about [w] itself? It was described in the last chapter as labialvelar. So, [p], [b], [m], [f], [v], *and* [w] all involve a 'labial articulation', i.e. the lips. It would seem, then, that the prohibition on the cooccurrence of [p], [b], [m], [f], [v] followed by [w] is a restriction on two labial segments occurring together at the beginning of a syllable. In other words, we can state a phonotactic generalization about the facts we have

been considering here: a labial consonant followed by a labial approximant in the same syllable is disallowed in English.

Without going into the details of syllables and syllable structure, we have seen that phonotactic restrictions can be stated in terms of syllables, for instance that in English [h] can occur only at the beginning of a syllable and [ŋ] only at the end. We have also seen that allowable combinations of speech sounds can be stated in terms of syllables, that for instance in English a labial consonant can be followed by [w] only when the two are in different syllables.

Key points

- Languages have 'phonotactic restrictions', allowable combinations of speech sounds that may occur in specific positions in syllables
- Languages also have restrictions on the occurrence of specific segments or segment types in specific syllable positions, for instance restricted to occurring in an onset or a coda
- Phonotactic restrictions are language-specific and may differ from language to language
- The syllable is the key to understanding these restrictions

Exercise 3.1 – Counting syllables

For each of the words below state how many syllables it has and indicate where you think that the syllable boundaries fall. For instance, *elephant* has three syllables, [.ˈɛ.lə.fənt.]. (It is probably easiest to represent the syllable boundaries using a transcription, since English writing does not always clearly reflect the sounds involved.) And please do not use a dictionary – rely on your own knowledge of English!

a)	table	b)	town	c)	mobile	d)	transept
e)	rhinoceros	f)	idea	g)	psychic	h)	conundrum

i) lemon j) telephone k) honesty l) punitive

3.3 Phonemes and allophones

In the last section we looked at syllables and phonotactics. Interestingly, syllables and syllable boundaries are not always clearly identifiable phonetically, yet syllables can help us make phonological generalizations, for instance about the phonotactics of a language. Another place where phonetics and phonology differ has to do with native speaker intuitions, where native speakers of a language may consider phonetically different sounds 'the same' in some real sense. Let us turn now to this and to the distinction between **phonemes** and **allophones**, which will be explained below.

Consider two set of words of English, *tack, stack,* and *cat*, and *leaf* and *fill*. As an experiment, ask some speakers of English (who are not studying language and linguistics!) whether the 't'-sounds in *tack, stack,* and *cat* are the same. Then ask them if the 'l'-sounds of *leaf* and *fill* are the same. It is very likely that in both cases the native speakers you ask will answer that, yes, the 't'-sounds in *tack, stack,* and *cat* are the same, and the 'l'-sounds of *leaf* and *fill* are the same.

Now consider the phonetic transcription of the words in question: [tʰæk], [stæk], [kæʔ][1] and [liːf], [fɪɬ]. As you learned in the previous chapter, phonetic transcription is done on a strictly 1-symbol:1-sound basis. If two different symbols are used, that means that there are two

[1] For some speakers the last sound in words like this tends to be an 'unreleased' [t˺], rather than glottal stop, [ʔ].

different sounds. So here the 't'-sounds are phonetically [t^h], [t] and [ʔ]. The 'l'-sounds are phonetically [l] and [ɬ]. In other words, there are three phonetically different 't'-sounds and two phonetically different 'l'-sounds. Why, then, should native speakers of English think that these different 't'-sounds are the same, or that these different 'l'-sounds are the same? And more importantly for our purposes, how can we resolve this apparent contradiction that phonetically different sounds are perceived by native speakers as 'the same'?

The answer lies in the phonology, the abstract system underlying the speech sounds of, in this case, English. Let us assume that in some respect native speakers are correct that there is one 't'-sound and one 'l'-sound. Let us also assume that the native speaker's 't'-sound somehow corresponds to the phonetically different 't'-sounds, and the native speaker's 'l'-sound likewise maps onto the phonetically different 'l'-sounds. In doing so, we could say that the 't'-sound = [t^h], [t] and [ʔ], and the 'l'-sound = [l] and [ɬ]. Using a diagram, we might represent these relationships as in (1):

(1)

In a sense this allows us to represent the relationship between the native speakers' intuition about there being a 't'-sound and an 'l'-sound, because the diagram in (1) shows that the native speakers' 't'-sound corresponds to three different sounds, and that their 'l'-sound corresponds to two different sounds. But we also need to ask if we are justified in doing this. In other words, is a representation like this merely a convenience for us to try to understand the organization of the speech sounds of English, or can we find further justification for it?

If the behaviour of native speakers were random, a diagram like that in (1) might be just a convenience. But, crucially, the occurrence of the 't'-sounds and the 'l'-sounds in native speakers' speech is not random, it is entirely predictable on the basis of where the sound occurs (also taking into consideration some variation across dialects of English). In other words, the aspirated [t^h] occurs only in specific places, for instance at the beginning of a word like *tap* [t^hæp]. It also occurs at the beginning of a **stressed syllable** as in *attack* [ə't^hæk]. (**Stress** here refers to syllable prominence, that the second syllable of attack is more prominent. For English, stress corresponds to higher pitch and greater volume.) Importantly, aspirated [t^h] does not show up at the ends of words in English, e.g. *[kæt^h] or following [s] at the beginnings of words (or more precisely, syllables), as in *[st^hæk]. Similarly, the 'l'-sounds of *leaf* and *fill* cannot change places: *[ɬi:f], *[fɪl][2]. This tells us that not only is the occurrence of 't'-sounds and 'l'-sounds not random, since we can predict on the basis of phonetic environment which phonetic 't'-sound we will find in which position.

To formalize this a bit, what we have been calling the native speaker's 't'-sound we can refer to as 'phoneme /t/'. The 'l'-sound recognized by the native speaker is 'phoneme /l/'. Note the formalism of the slashes, / /: a symbol appearing between slashes is considered to be a 'phoneme', an abstract phonological unit distinct from actual phonetic production. In the two cases we have been looking at we can say that phoneme /t/ is related to three speech sounds,

[2] Some varieties of English tend to have either clear-l, [l], or dark-l, [ɬ] . For such varieties there is only one 'l'-sound, even phonetically.

[t^h] [t] and [ʔ]. These are known as 'allophones', the concrete phonetic speech sounds related to a particular phoneme. Likewise, phoneme /l/ has two allophones, 'clear-l' [l] and 'dark-l' [ɬ].

We are now in a position to express the relationships in (1) more formally as in (2). Here the native speakers' intuition is represented as a phoneme, which corresponds to one or more allophones.

(2)

phonemes	/t/		/l/
allophones	[t^h] [t] [ʔ]		[l] [ɬ]

We noted above that speakers' use of specific allophones is not random. So, the one thing that is still missing at this point is a statement about the distribution of the allophones, in other words, information about the context in which each of the allophones is found. There are various ways of encoding this information. For our purposes, let us rely on 'distribution statements', descriptive statements about the context in which each allophone of a particular phoneme is found. For phoneme /t/ we need to say that the [t^h] allophone occurs at the beginning of a syllable, the [t] allophone occurs following [s], and the glottal stop allophone [ʔ] occurs at the end of a syllable. This information is given in (3), where the forward slash means that what follows is the relevant context, the underscore indicates the position of the allophone relative to its surroundings. The '$_\sigma$[' means 'at the beginning of a syllable'; ']$_\sigma$' means 'at the end of a syllable'; lowercase sigma, σ, stands for 'syllable'.

(3) phoneme /t/: [t^h] / $_\sigma$[_ e.g. *tack*

[t] / $_\sigma$[s_ e.g. *stack*

[ʔ] / _]$_\sigma$ e.g. *kat*

There are some important properties associated with phonemes and allophones. Phonemes are said to be in '**contrastive distribution'**, while the allophones of a given phoneme are said to be in '**complementary distribution'**. Let us see what this means. In English, /t/ and /p/ are both phonemes. We can be sure of this because they occur in '**minimal pairs**', i.e. in words where there is a difference in meaning but a phonetic difference in only one sound. For example, *tack* and *pack* differ only in the first sound, [t^hæk] vs. [p^hæk], while *stat* and *spat* differ only in the second sound, [stæt] vs. [spæt]. So, we can say that /t/ and /p/ contrast in English; this sort of contrast, or contrastive distribution, is a property of phonemes.

Now consider the allophones of /t/. Do they contrast in the way we just saw for /t/ and /p/? No. We are able to say that /t/ and /p/ contrast because they can occur in exactly the same environment – e.g. at the beginning of a word, or following [s] – and when they do so they change the meaning of the word. On the contrary, the allophones of /t/, that is [t^h] [t] and [ʔ], cannot do this. Where one allophone of /t/ occurs, a different allophone of /t/ does not occur. So, [t^h] occurs in *tack* [t^hæk] but not in *stack* [stæk], where unaspirated [t] occurs. Interestingly, even if you did pronounce [stæk] as [st^hæk] it would not become a different word with a different meaning, it would just be a weird pronunciation of *stack*. That is because, as allophones, [t^h] [t] and [ʔ] are in complementary distribution. If, on the other

hand, you pronounced *tack* as [pʰæk] it *would* be a different word and therefore misunderstood, because phoneme /t/ and phoneme /p/ are in contrastive distribution.

As we saw earlier in the chapter, phonotactic restrictions differ between languages. Similarly, the distribution of speech sounds and the relationship between phonemes and allophones are also language-specific. In other words, two sounds that are allophones in one language may be separate phonemes in a different language. For example, both English and Thai have the sounds [tʰ] and [t]. However, although [tʰ] and [t] in English are allophones of phoneme /t/, we find a different relationship in Thai. In that language [tʰ] and [t] are separate phonemes. We can tell this because [tʰ] and [t] contrast to form minimal pairs in Thai, e.g. [tûː][3] 'cabinet' vs. [tʰûː] 'blunt', [tam] 'to pound' vs. [tʰam] 'to do', [tɔ̀j] 'punch' vs. [tʰɔ̀j] 'despicable'. So, for Thai we have to say that these two sounds are separate phonemes, /t/ and /tʰ/, unlike English where [t] and [tʰ] are allophones of the same phoneme /t/.

Key points:

- The speech sounds of a language can be divided into 'phonemes' and 'allophones'
- Phonemes contrast with each other – as seen in minimal pairs
- Allophones do not contrast with each other and although they are phonetically different, native speakers often hear allophones of a single phoneme as 'the same'
- The identification of phonemes and allophones is language specific; allophones in one language may be phonemes in another

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Exercise 3.2 – Phonemes vs. allophones

3 The accent marks here indicate tones. They can be safely ignored for our purposes.

i) Spanish (Indo-European; Spain & Latin America)

We know that [d] and [ð] are separate phonemes in English because they contrast in minimal pairs like *<u>d</u>oze* and *<u>th</u>ose*, *la<u>dd</u>er* and *la<u>th</u>er.* Consider the same two sounds of Spanish in the following data and decide whether [d] and [ð] are separate phonemes or allophones of the same phoneme. Explain your decision. The data are given in transcription, not Spanish orthography, and you have enough data to decide.

1)	naða	'nothing'	4)	dezde	'since'	7)	roðar	'to roll'
2)	deðo	'finger'	5)	donde	'where'	8)	de	'from'
3)	dɑr	'to give'	6)	deðonde	'whence'	9)	kwɑndo	'when'

ii) Tojolabal (Mayan; Mexico)

Consider the sounds [k] and [kˀ] (glottalized-k) in the following data and determine whether they are allophones of a single phoneme or separate phonemes. What kind of argument(s) can you develop for your position?

1. kisim	'my beard'	7. ʧakˀa	'chop it down'
2. kˀak	'flea'	8. koktik	'our feet'
3. pˀakan	'hanging'	9. kˀaʔem	'sugar cane'
4. sak	'white'	10. kˀiʃin	'warm'
5. kˀuutes	'to dress'	11. skuʧu	'he is carrying it'

6. snika ‘he stirred it’ 12. ʔakˀ 'reed'

There is one final point to mention with respect to phonemes and allophones, and that is ‘**neutralization**’. Neutralization is not terribly important, but it can be a confounding factor when trying to decide on the status of some segment as either a phoneme or an allophone. A contrast between two phonemes is said to be neutralized when, in a particular context, the two phonemes share a single allophone. Consider **flapping** in American or Irish English (there are other varieties that have flapping, too, but these two dialects are often cited). As you can easily establish, [t] and [d] are phonemes - /t/ and /d/ - in English, as supported by words like *tear* and *dear*, *bat* and *bad*. All varieties of English have this sort of contrast between /t/ and /d/. But what about *ladder* and *latter, Adam* and *atom*? In varieties of English with flapping, both /t/ and /d/ occur as flap, [ɾ], between two vowels when the first vowel is stressed. So, in American English both *ladder* and *latter* are pronounced as ['læɾəɹ], *Adam* and *atom* are both ['æɾəm]. Even though /t/ and /d/ contrast elsewhere, in this position the contrast is neutralized. Consequently, we can say that /t/ and /d/ are phonemes of English, but that the contrast is neutralized between two vowels when the first vowel is stressed. Note, too, that there is further evidence that the [ɾ] in *atom* really is an allophone of phoneme /t/: compare the related word *atomic* [ə'tʰɑmɪk]. In *atomic*, the /t/ shows up as [tʰ] before a stressed vowel. Here, [ɾ] and [tʰ] occur in complementary distribution with each other: [ɾ] occurs following the stressed syllable, while [tʰ] occurs before the stressed syllalble. Given this complementary distribution, that means that [ɾ] is a further allophone of /t/ in these

varieties. Just as [ɾ] is also an allophone of /d/ occurring in *ladder* and *Adam*. The neutralization refers to the fact that both phoneme /d/ and phoneme /t/ share the allophone [ɾ] in this particular position.

3.4 Alternations and conditioning factors

Allophones are contextual variants of specific phonemes. For instance, as we have seen, [t^h] is an allophone of /t/ which occurs in the context of the beginning of a syllable; [t] is an allophone of /t/ which occurs in a consonant cluster following [s]. In other words, a specific allophone of a particular phoneme occurs in a precise environment or set of environments. These environments may be purely phonetic, meaning that the only relevant information is the phonetic context. Or they may be a combination of phonetic **conditioning** together with morphological information, for instance the presence of a particular kind of prefix or suffix or grammatical marker (Chapter 4 focuses on morphology). Or the alternations can be associated with phonetic, morphological and lexical factors, where only specific words exhibit a certain alternation. We will look at these different **conditioning factors** in the next few sections.

3.4.1 Phonetic conditioning

The environment in which a particular allophone occurs may be defined purely phonetically. In this case, the conditioning context can be said to be phonetic. Take for instance the allophones of /n/ in English. Phoneme /n/ has several distinct allophones, including [n], [m], [ŋ], depending on the place of articulation of a following obstruent. So, phoneme /n/ occurs

as [n] in words like *indeed* [ɪnˈdiːd] and *onto* [ˈɔntuː], but shows up as [m] in words like *input* [ˈɪmpʊt] and *unbroken* [ʌmˈbɹoʊkən]. Phoneme /n/ also occurs as [ŋ] in words like *ink* [ɪŋk] and *uncle* [ˈʌŋkl̩].

It becomes particularly clear that this is phonetic conditioning when we consider what happens in a different sort of syntactic context, but where the shape of /n/ can still be attributed to a following obstruent. Consider the preposition *in* of English. In isolation, or when followed by a vowel, this preposition is pronounced [ɪn]. It is also pronounced [ɪn] when followed by an alveolar consonant, e.g. [t] or [d] or [n]:

(4) [ɪn] Africa [ɪn] Texas [ɪn] Durham [ɪn] Norwich

However, in normal speech, that same preposition is pronounced [ɪm] before a bilabial consonant, [p], [b], [m], and it is pronounced [ɪŋ] before the velars [k] or [g] (presumably it would also be pronounced [ɪŋ] before [ŋ], but as we noted earlier, there are no [ŋ]-initial nouns in English).

(5) [ɪm] Paris [ɪm] Boston [ɪm] Manchester

[ɪŋ] Crete [ɪŋ] Greece -----

We can see from the examples in (4) and (5) that the allophones of phoneme /n/: [n], [m] and [ŋ], are phonetically conditioned. The shape of /n/, that is, whether it occurs as alveolar [n],

bilabial [m] or velar [ŋ], is determined entirely by the phonetic characteristics of the segment that follows /n/. In this case, the important phonetic characteristic is the place of articulation of the following consonant.

Another example of phonetic conditioning in English involves the alternation between oral and nasal vowels. In English, unlike some other languages like French, Polish, Navajo, the difference between nasal vowels and oral vowels is not phonemic – there are no minimal pairs in English based solely on whether a vowel is oral or nasal. Nonetheless, phonetically English does have both oral vowels and nasal vowels, as shown in (6), where the nasal vowels are shown with a tilde, ˜ , over the vowel.

(6) *cat* [kʰæt] *can* [kʰæ̃n]
sit [sɪt] *sin* [sĩn]
suit [sut] *soon* [sũn]

If you need convincing that the vowels in *can*, *sin*, and *soon* really are nasalized, try pronouncing those words while pinching your nose. The airflow, in particular the effect of stopping the airflow through the nose, indicates that the vowels are nasalized. And the words in (6) show the phonetic conditioning of vowel nasalization in English: the words ending with a nasal consonant, here [n], have a nasal vowel, while those ending in an obstruent have an oral vowel. The same is true of words ending with the nasals [m] or [ŋ], like *ham* and *hang*. Compare both of these words with *hat*, which has an oral vowel.

(7) *ham* [hæ̃m] *hang* [hæ̃ŋ] *hat* [hæt]

The phonetic environment is not the only type of conditioning factor that can influence the

distribution of allophones of a specific phoneme. That distribution can also be affected by a combination of phonetic factors together with morphological considerations.

3.4.2 Phonetic and morphological conditioning

Linguistic morphology – the study of word formation – is the topic of Chapter 4. Nonetheless, for the moment we only need to recognize a single suffix, the plural marker of English, written *-s* or *-es*. The first thing to notice is that there are three ways of pronouncing this suffix, as shown in (8):

(8)

tree[z]	*hedg*[ɪz]	*bat*[s]
field[z]	*ditch*[ɪz]	*wasp*[s]
maple[z]	*ash*[ɪz]	*oak*[s]

The shape of the suffix, i.e. its pronunciation, depends on two things. First, it depends on the final segment of the noun that it is attached to. So, following a voiced segment such as a vowel, as in *tree*, or a voiced stop, as in *field* , or a sonorant, as in *maple*, the suffix appears as [z]. Following a voiceless stop, as in *bat*, *wasp* and *oak*, the suffix appears as [s]. What about *hedge*, *ditch* and *ash*? In each of these cases the final segment is a 'sibilant', an affricate in the case of *hedge* and *ditch*, a fricative in the case of *ash*. In each case when it follows a sibilant, the suffix appears as [ɪz]. Try this with other nouns of English, ending with other segments that we have not considered in (8). You will find the same pattern: [z] following a voiced non-sibilant, [s] following a voiceless non-sibilant, and [ɪz] following a sibilant.

There are two interesting things to note at this point. First of all, we can tell that this is not a

purely phonetically conditioned alternation, since normal English phonology does allow a voiced segment followed by [s], as in *hence* [hɛns] and *since* [sɪns]. Itis only when the [n] is noun-final and the following sibilant is the plural marker that we need to have [z], as with the noun *hen*, the plural of which is *hen*[z], not **hen*[s]. The second interesting point is that as a morphologically governed alternation, selection of the correct shape for the plural marker is productive. If you invent a new word of English, it will behave according to the patterns seen above. So, the word *bleem* will be pluralized as [bliːmz], not *[bliːms], *trat* will be [tɹæts], not *[tɹætz], and *plotch* will be [plɒtʃɪz]. So although the alternation is slightly complex, involving both phonetics and morphology, it is entirely systematic for regular noun pluralization in English.

3.4.3 Morphological and lexical conditioning

Before leaving the topic of phonological alternations, there is one more type of conditioning to briefly consider: morphological and lexical conditioning. We have already seen that morphological conditioning refers to some phonological alternation involving some morphological object, in the example above this was the regular plural marker of English. Sometimes an alternation can be restricted to a specific set of lexical items, i.e. words, in a language. Consider the words in (9).

(9) *leaf* [liːf] ~ *leaves* [liːvz]

thief [θiːf] ~ *thieves* [θiːvz]

house [haʊs] ~ *houses* [haʊzɪz]

hoof [huf] ~ *hooves* [huvz]

With the words in (9) there is an alternation in the stem-final consonant, [f] alternating with [v], and [s] alternating with [z]. This is considered to be lexically conditioned, because only a small, closed set of words in the language participate in the alternation. Consider, for instance, the words *kiss* and *cliff*. They are not members of the set of words which participate in this alternation, so they have regular plurals, [kisɪz] and [klɪfs], not *[kizɪz] and *[klɪvz].

Key points
The alternations between allophones of a phoneme may be associated with different sorts of 'conditioning factors'. These include:
- Phonetic conditioning, where the relevant factor is phonetic context
- Morphological conditioning, where specific morphological factors are relevant
- Lexical conditioning, where the alternation is specific to a particular word or type of word

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Exercise 3.3 – Phonemes and alternations

Kurdish (Indo-Aryan; Iraq, Iran, Turkey and Syria)

Consider the alternations between the final consonant in the words in the left-hand column and the corresponding consonant in the right-hand column (underscored):

[kɨtep] 'book'	[kɨteb̲aka]	'the book'
[bart] 'stone'	[bard̲a]	' it is stone'
[sak] 'dog'	[sag̲akat]	'your dog'

What are the two possible analyses, assuming that for each alternation, [t] ~ [d], [p] ~ [b], [k] ~ [b], there is a single **underlying** phoneme?

Now consider these further data. They support one of the possible analyses. Which analysis

do they support, and what evidence do they provide?

[kup] 'cup'	[kupaka]	'the cup'
[dɨrk] 'thorn'	[dɨrkaːwi]	'thorny'

3.5 The syllable

In earlier sections of this chapter we referred to the syllable as playing a role in determining phonotactic restrictions, in particular, that certain combinations of segments such as [p]+[w] in English could occur across syllables, but not within a single syllable. In this section we will look a little more closely at the syllable and see that there are other important aspects to the syllable beyond phonotactics and syllable boundaries alone, and that the syllable itself has internal structure.

Consider the following words of English: *bit*, *bid*, *hat*, *had*, *bet*, *bed*, *seat*, *seed*, *see*, *suit*, *sued*, *sue.* If we look at transcriptions of these words, we see an interesting pattern emerging.

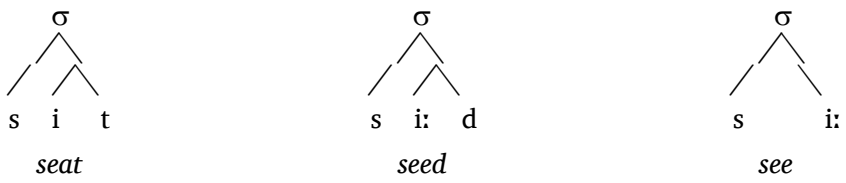
(10)

bit [bɪt]	bid [bɪːd]	
hat [hæt]	had [hæːd]	
bet [bɛt]	bed [bɛːd]	
seat [sit]	seed [siːd]	see [siː]
suit [sut]	sued [suːd]	sue [suː]

What is interesting here is that the phonological contrast – as supported by minimal pairs – is between [t], [d] or zero at the end of the word. Nonetheless, there is something else going on

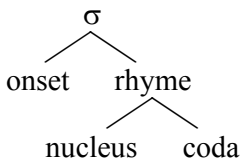
as well, a difference in vowel length. *Bit, hat, bet, seat* and *suit* all have short vowels, while *bid, had, bed, seed, sued, see* and *sue* all have long vowels. Where the syllable, or more precisely syllable structure, comes in is that in those cases with short vowels, there is a voiceless obstruent at the end of the syllable. When the vowel is long, the syllable is either closed with a voiced obstruent, or the syllable is open. This is shown in (11).

(11)



The lowercase sigma, σ, represents the 'syllable node', i.e. the whole constituent of the syllable. As noted in the previous chapter, the nucleus of the syllable, the most important part, is usually a vowel; here it is the [i] or [iː]. The beginning of the syllable, if there is material before the nucleus, is known as the '**onset**', while any material following the nucleus is called the '**coda'**. The node dominating both the nucleus and the coda is called the '**rhyme'**.

(12)



So, what appears to be happening in the data in (10) is that when a syllable is closed with a voiceless obstruent in the coda in English, the preceding vowel is short. Otherwise, when the syllable is open (lacking a coda) or when the syllable is closed with a voiced obstruent in the coda, the vowel is long. This is a systematic occurrence in the phonology of English.

Recall the earlier discussion of the allophones of phoneme /l/, and that the difference was between 'clear-l', [l], in *leaf* as phonetically distinct from the 'dark-l', [ɬ], in *fill*. We're now in a position to be a bit more precise about the distribution of these two allophones. Clear-l, [l], is found in onset position, dark-l, [ɬ], in coda position.

(13)

leaf *fill*

There are certain aspects to the syllable that are assumed to be universal: for instance that all spoken languages contain syllables consisting of an onset and nucleus, i.e. CV, where 'C' stands for 'consonant' and 'V' for 'vowel'; that all languages allow vowels in the nucleus. At the same time, there are also many language-specific aspects to the syllables of particular languages, such as the number of consonants allowed in onsets or codas; whether onsetless syllables are allowed. As to number of consonants in onsets and codas, English, for example, allows a maximum of three consonants in the onset, of which the first must be [s], the second a voiceless stop, [p], [t] or [k], and the third a sonorant, either [l] or [ɹ], as in *split* [splɪt], *strike* [stɹaɪk], or *scream* [skɹiːm]. Some languages allow a maximum of two consonants in the onset. Others, e.g. Polish, allow up to four consonants in the onset, e.g. [vzglãd] 'consideration' and [drgnãts] 'shudder'. Some languages, like English and French, allow vowel-initial syllables, e.g. *eye* [aɪ] and *eau* [o] 'water', while others, e.g. German and Arabic, require an onset, so words spelt with a vowel at the beginning are nonetheless

pronounced with an initial glottal stop, e.g. German *Adler* [ˈʔɑdlʌ] 'eagle', *ohne* [ˈʔoːnə] 'without', and Arabic *akhbar* [ʔɑxbɑr] 'news' and *eid* 'festival' [ʔiːd].

The number of consonants permitted in the coda, too, is language-specific. Some languages, e.g. Fijian and Hawai'ian, allow no coda consonants, meaning that all words must end in a vowel. Other languages permit varying numbers of consonants in the coda. English, for instance, allows up to four, e.g. in a word like *sixths* [sɪksθs] (although words like this in English are relatively rare).

Along with language-specific aspects of syllable structure, like required vs. permitted numbers of segments in onsets and codas, remember too that certain other aspects of phonology, like the distribution of allophones, are also language-specific. It is a fact about English that clear-l occurs in onsets and dark-l in codas; it is a fact about English that vowels are lengthened in open syllables and in syllables closed with a voiced segment. We can also find language-specific phenomena related to both fairly general aspects of syllable structure, e.g. French 'closed syllable adjustment', which distinguishes simply between open and closed syllables, and phenomena associated with specific segments occurring in specific positions, e.g. vowel length in Welsh monosyllabic words. In the Welsh case, native monosyllabic words with [p, t, k, m, ŋ] in the coda, or with more than one consonant in the coda, have a short vowel; monosyllabic words with no coda or with any of the other consonants of Welsh in the coda, have a long vowel[4].

[4] In fact, things are slightly more complicated than this, in that [n] and [r] in the coda of a monosyllabic word

As a final illustration of the importance of syllable structure, let us look at French closed syllable adjustment. Among the vowels of French we find the mid central vowel [ə], as in the first syllable of *petit* [pəti] 'small, masc.', [e] as in *été* [ete] 'summer', and [ɛ] as in *lait* [lɛ] 'milk'. While all three of these vowels can occur in open syllables, as in the examples given, in a closed syllable we find only one of them, [ɛ]. Thus we can find an alternation between [ə] and [ɛ] and between [e] and [ɛ]. Such an alternation is most clearly shown in related words in which the vowel in question is [ə] or [e] in an open syllable, but appears as [ɛ] in a closed syllable. This is illustrated in (14), where the relevant syllable boundaries are shown and the alternating vowel underlined.

(14)

sécher [.se̲.ʃe.] 'to dry'	but	*sèche* [.sɛ̲ʃ.] 'dry, fem.'
premier [.prə.mje̲.] 'first, masc.'	but	*première* [.prə.mjɛ̲ʁ.] 'first, fem.'
peser [.pə̲.ze.] 'to weigh'	but	*pèse* [.pɛz.] 'I weigh'
mener [.mə̲ne.] 'to lead'	but	*mène* [.mɛ̲n.] 'I lead'

In this French case, the relevant factor is simply the occurrence of the vowel in question in either an open or a closed syllable. The specifics of that syllable, e.g. type of consonant in the coda, are irrelevant.

may follow either a long or a short vowel.

Key points
- Recognizing the syllable and syllable structure help in accounting for phonological alternations
- Syllable position, for instance occurrence in an onset as opposed to occurrence in a coda, may be relevant in characterizing an alternation
- Open vs. closed syllable may be relevant in accounting for an alternation
- The characteristics of a segment in a particular position may be important, such as between a voiced segment in a coda as compared with a voiceless segment in a coda

Exercise 3.4 – Stress and syllable structure

Mohawk (Algonquian; North America)

Note the interaction between stress and syllable structure. A stressed vowel is indicated with an acute accent, ˊ, over the vowel. In particular, how do stress and syllable structure predict the occurrence of long vowels?

.wísk.	'five'	.ké꞉.saks.	'I look for it'
.í꞉.raks.	'he eats it'	.jék.reks.	'I push it'
.rá꞉.kʌs.	'he sees her'	.ra.jʌ́t.hos.	'he plants'

Now consider the following words of Mohawk. For each case, say whether the underlined vowel should be long or short, and explain why.

.ra.ké .tas.	'he scrapes'	.ro.jó ʔ.teʔ.	'he works'

3.6 Syllable weight

Apart from syllable structure itself, whether a syllable is open or closed, whether or not it has an onset, and so on, there is also a distinction made between 'light' and 'heavy' syllables. We

can see this distinction in stress assignment in English. In English a syllable counts as 'light' if it is an open syllable with a short vowel. So, the first syllable of *between* [.bə.ˈtwiːn.], *about* [.ə.ˈbaʊt.] and *elegy* [.ˈɛ.lɪ.ʤiː.] is light. A heavy syllable, on the other hand, has either a long vowel or diphthong in the nucleus, or is closed with a consonant. So, the first syllable of *open* [.ˈoʊ.pən.], *island* [.ˈaɪ.lənd.], *easel* [.ˈiː.zəɬ.], and *athlete* [.ˈæθ.liːt.] is heavy.

While the stress system of English as a whole is rather complex, and there are various exceptions to the generalizations, there are nonetheless some interesting observations that can be made about stress assignment to specific classes of English words relative to syllable weight. Let us look briefly at the patterns of stress assignment to nouns and verbs. Typically, nouns of two syllables have stress on the first syllable, regardless of the weight of that syllable, e.g. *island* and *athlete*, with a heavy initial syllable, but also *carrot* and *forest* with light initial syllables. For nouns of English of more than two syllables, stress typically falls on the penultimate syllable, if that syllable is heavy, e.g. *computer* [.kəm.ˈpjuː.tə.][5], *enclosure* [.ɛn.ˈkloʊ.ʒə.], *navigation* [.næ.vɪ.ˈgeɪ.ʃn̩.]. If, on the other hand, the penultimate syllable is light, stress falls on the antepenultimate syllable, even if that syllable itself is light, e.g. *elephant* [.ˈɛ.lə.fənt.], *testament* [.ˈtɛ.stɪ.mənt.], *precedent* [.ˈpɹɛ.sɪ.dənt.].

Turning to verbs, here too we can find some interesting patterns associated with heavy and light syllables – and some further complexities. Where the weight of the penultimate syllable

[5] Pronouncing the final <r> here makes no difference to the stress: [.kəm.ˈpjuː.təɹ.]

is important in nouns, for verbs the weight of the final syllable is important. With verbs like *reveal* [.ɹɪ.ˈviːɬ.], *defend* [.dɪ.ˈfɛnd.], and *respect* [.ɹɪ.ˈspɛkt.], the final syllable is heavy and stress falls on that syllable. With verbs like *envy* [.ˈɛn.vi.], and *pity* [.pɪ.ti.], where the final syllable is light, stress falls on the penultimate syllable.

The verbs of English also illustrate an interesting situation in which phonetic material is phonologically invisible, referred to as **extrametricality**, meaning literally outside the assignment of stress. Take the verbs *enlighten*, *nourish*, and *imagine*. According to what was said in the last paragraph, we might expect these words to be stressed on the final syllable which appears to be heavy: **enlighTEN, *nouRISH*, **imaGINE*. What appears to be happening here though is that the final consonant is ignored by the stress assignment process. It is as if the words were *enlighte*, *nouri* and *imagi*. But note that these words fall into line with the pattern observed above if the final consonant is ignored. Without the final [n], [ʃ], and [n], *enlighten, nourish,* and *imagine* have a final light syllable consisting of a single short vowel. Note, too, that this is not a trick of analysis either. Consider the words listed earlier as illustrating verbs with heavy final stress-attracting syllables, *reveal*, *defend* and *respect.* Even if the final consonant is removed from these words, they still have a heavy final syllable, i.e. [.ɹɪ.ˈviː.], [.dɪ.ˈfɛn.] and [.ɹɪ.ˈspɛk.]. So, it appears to be the case that, for whatever reason, the final consonant of verbs is ignored by the phonological process assigning stress to English words. If, with the final consonant ignored, the final syllable is still heavy, it attracts the stress. If, with the final consonant ignored, the final syllable is light, stress retracts to the penultimate syllable.

Although as we have seen there are some interesting generalizations to be made concerning syllable weight and English stress assignment, not all stress systems are sensitive to syllable weight. Some, like Welsh and Czech, are purely positional systems, insensitive to the weight of the syllables involved. In Welsh, the penultimate syllable typically bears the main stress of the word, regardless of whether that syllable is heavy or light. Czech, on the other hand, stresses the initial syllable in a word. Again, the weight of that syllable, whether heavy or light, is irrelevant.

Even in English we can find apparent instances of stress by position. Consider the nominalizing suffix *–ity*, that is, the suffix attached to adjectives to create nouns, for example *electric* > *electricity*, *curious* > *curiosity*, *human* > *humanity*. In each of these cases stress falls on the syllable immediately to the left of the suffix, *elecTRIcity*, *curiOsity*, *huMAnity,* which sounds like it could be positional stress assignment. Interestingly, too, the stress on the noun in each of these cases is different from the stress on the adjective – *eLECtric, CURious, HUman.* But is this really stress by position? The suffix *–ity* consists of two syllables, a light penultimate syllable [ɪ] followed by a further final light syllable [ti]. So, nouns formed with the suffix *–ity* simply conform to the basic stress placement algorithm for nouns: if the penultimate syllable is light, stress normally falls on the antepenultimate. In these cases, the antepenultimate syllable happens to systematically correspond to the final syllable of the stem.

Key points
In addition to syllable structure, syllable weight can also play a role in phonology

- Syllables can be light or heavy
- The distinction between light and heavy is different from the distinction between open and closed syllables
- Some stress assignement systems are sensitive to syllable weight; in such systems stress is often attracted to a heavy syllable

3.8 Conclusion

In this chapter we have considered a number of aspects of the organization of the sound system of spoken language typically referred to as phonology. We have seen that there is more to understand with respect to the speech sounds of language than simply the physical properties of those sounds, their articulation, their mutual influence on each other, their perception and so on, as important as those aspects are. Understanding that the sounds we produce when speaking our language are related to abstract phonemes allows us to reconcile the fact that native speakers of any language will regard certain sounds as 'the same' despite demonstrable phonetic difference between those sounds. As we have seen, it helps us understand that despite the phonetic fact that the sounds [t^h], [t] and [ʔ] are distinct, English speakers nonetheless consider them in some sense 'the same'. We can account for this by assuming that in English the phoneme /t/ occurs as [t^h], [t] or [ʔ] in specific environments.

We have also seen that phonology allows us to understand something about phonotactics, the permissible combinations of speech sounds in a language. Including, for instance, that in a particular language a specific sequence of sounds may be perfectly permissible provided that that sequence does not occur within a syllable. Recognition of the syllable as a unit of analysis then led us on to consider other aspects of the systematic organization of speech sounds, including the role of syllable structure in phonological processes themselves, such as French closed syllable adjustment, the relationship between syllable structure and vowel length in English, as well as the phenomenon of vowel nasalization in English. We saw further that syllable structure, specifically syllable weight, allowed us to describe typical

stress assignment for nouns and verbs in English.

As a final illustration of the distinction between phonetics and phonology, and the role of phonology beyond the surface phonetic structure, consider the following sentence of English in two different dialects:

(18) (a) [ðə ɹɛd kɑː ˈkw̥ɪkliː stɒpt ðɛn ˈstɑːtəd əˈgɛn]

(b) [ðə ɹɛd kɑɹ ˈkw̥ɪkliː stɑpt ðɛn ˈstɑɹɾəd əˈgɛn]

The transcription in (18a) is standard British English. The transcription in (18b) is General American. Note first of all the differences between the two. Even in this very short sentence, there are some differences both in the vowels and in the consonants. In the transcription of *car* and *started* (18a) has a long vowel where (18b) has a short vowel followed by [ɹ]. The two transcriptions have a different vowel in the word *stopped*, and (18b) has a flap, [ɾ], in one case where (18a) has a [t], in the word *started*, but the other [t]s match in both transcriptions. Although this is a brief comparison, and although the differences are few here, consider the implications of it: how is it that British and American speakers of English can understand each other? How can the British listener come to understand that the American flap corresponds to the British [t]? Or that the British [ɒ] vowel may correspond to the American [ɑ]? Indeed, take two more divergent varieties of English than standard British and General American and, apart from differences in the words used, speakers of those two varieties will (with some practice) come to understand each other's variety with few difficulties. How is that possible? We certainly cannot do it with a foreign language. The answer lies in the phonology, in the correspondence between the abstract phonological representations and the

surface phonetics.

Assuming that each speaker of English has unconscious knowledge of their phonological system, in particular the correspondence between their surface phonetics and the phonological representations, e.g. phonemes, the task of understanding another variety of English boils down to this: becoming familiar enough with the other variety to map the phonetic surface structure of that variety to the phonological representations of one's own dialect. It is very hard to see how this could happen relying on the surface phonetics alone. But by means of the phonology, it becomes a more straightforward exercise, mapping from a different dialect to your own phonological system.

(19) (a) [ðə ɹɛd kɑː ˈkw̥ɪkliː stɒpt ðɛn ˈstɑːtəd əˈgɛn]

/ ðə ɹɛd kɑɹ kwɪkli stɒpt ðɛn stɑɹtəd əgɛn /

(b) [ðə ɹɛd kɑɹ ˈkw̥ɪkliː stɑpt ðɛn ˈstɑɹɾəd əˈgɛn]

The illustration in (19) is simply meant to indicate that a speaker of one dialect could come to understand a speaker of a different dialect through the abstract underlying structures common to both. This suggests that at least with respect to the sound system, even a language with very divergent dialects may have a relatively unitary phonology.

In this chapter we have briefly examined aspects of the systematic organization of speech sounds. As we have seen, there are systematic behaviours in the speech sounds of language that cannot be attributed to the phonetics alone. We have also seen that some aspects of the sound system of language can be best understood at an abstract level of representation.

References and data sources

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Spanish data from: Quilis, A. and Fernández, J.A. (1972). *Curso de fonética y fonología españolas*, Madrid: Consejo superior de investigaciones científicas.

Kurdish data on final devoicing from Twana Hamid, personal communication

Thai data on phonemic status of stops from Pak Tong Sen, personal communication

Further reading

Carr, P. and Montreuil, J.-P. (2013). *Phonology*, Basingstoke: Palgrave Macmillan. [2nd ed.] – This is an introduction to phonology and phonological theory, assuming some knowledge of phonetics

Davenport, M. and Hannahs, S.J. (2010). *Introducing phonetics & phonology*, Oxford: Routledge [3rd ed.] – This is an introductory text to both phonetics and phonology, covering the material of Chapters 2 and 3 in greater depth and introducing the reader to phonological theory.

McMahon, A. (2002). *An introduction to English phonology,* Edinburgh: Edinburgh University Press. – This is a textbook of phonology focusing on the sound patterns of English.

Key to exercises

Answers to Exercise 3.1, English syllable count:

(a) two: .ˈteɪ.bl̩.	(b) one: .taʊn.	(c) two: .ˈmoʊ.baɪɬ
(d) two: .ˈtɹæn.sɛpt.	(e) four: .ɹaɪ.ˈnɔ.sə.ɹəs.	(f) three: .aɪ.ˈdi.ə.
(g) two: .ˈsaɪ.kɪk.	(h) three: .kə.ˈnʌn.dɹəm.	(i) two: .ˈlɛ.mən.
(j) three: .ˈtɛ.lə.foʊn.	(k) three: .ˈɔ.nɛ.stiː.	(l) three: .ˈpju.nɪ.tɪv.

Answer to Exercise 3.2 (i) Spanish: The sounds [d] and [ð] in Spanish appear to be allophones of a single phoneme, since [ð] appears only between two vowels, whereas [d] never appears in that position; [d] appears word initially and next to a consonant, environments in which [ð] doesn't appear. Moreover, you can see an alternation by comparing (5) [donde] 'where' with (6) [deðonde] 'whence': the second consonant in [deðonde] alternates with the first consonant in [donde]. Recognizing this as an alternation is supported by the meanings 'where' and 'whence' = 'from where'.

Answer to Exercise 3.2 (ii) Tojolabal: Plain [k] and glottalized [kˀ] can be said to be separate phonemes. In the first place, both appear word-initially, compare items (1) and (10) – indeed these two words are almost a minimal pair. Secondly, both appear between two vowels: items (3) and (7) contrast these two sounds between the vowel [a]. Thirdly, plain [k] and glottalized [kˀ] both appear word-finally, compare items (2) and (4) with item (12). Finally, there is no indication of an alternation involving these two sounds.

Answer to Exercise 3.3 Kurdish

Since in each case the voiced and voiceless stops appear in related words, there appears to be an alternation between [p] and [b], between [t] and [d], and between [k] and [g]. Assuming that one of each pair is the phoneme, the two possible analyses are either (1) that the voiceless member of each pair is the phoneme (for instance /p/), with a voiced allophone occurring between two voiced sounds (either a vowel or a sonorant) (e.g. [b]), as in the words in the right-hand column, or (2) that the voiced member of each pair is the phoneme (e.g. /b/), with a voiceless allophone occurring at the end of the word (e.g. [p]), as in the words in the left-hand column.

The further data show no alternation: the words for 'cup' and 'the cup' both have [p], while the words for 'thorn' and 'thorny' both have [k], even when the [p] and [k] are between two voiced sounds. That supports the position that in the alternating cases the phoneme is the voiced member of the pair; the voiceless one occurs word finally. Note, too, that this is a type of neutralization: there is reason to believe that both voiced and voiceless stops occur as phonemes, but in word-final position only the voiceless stop occurs.

Answer to Exercise 3.4 Mohawk

A stressed vowel is long in an open syllable. The stressed vowels in [.wísk.], [.jék.reks.], and [.ra.jʌ́t.hos.] appear in closed syllables, so they are short. The stressed vowels in the remaining words appear in open syllables, so they are long. The underlined vowel in [.ra.ké: .tas.] is stressed and in an open syllable, so it is long; the underlined vowel in [.ro.jó?.te?.] is stressed and in a closed syllable, so it is short.